



Research Article

Nutritional and structural evaluation of selected Black gram varieties for preparation of Fermented Thick Pancake (Dosa)

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Submitted: 27 February 2018

Approved: 09 March 2018

Published: 12 March 2018

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Keywords: Black gram varieties; Physicochemical parameters; Texture; Microstructure; Thick pancake (Dosa)

Abstract

The quality characteristics of selected black gram varieties viz., VBN 5, VBN 7, ADT 3, T9 and CO 6 and were evaluated for their suitability for the preparation of thick pancake. The foaming stability and foaming capacity were found to be maximum in VBN 5, CO 6 and T9. Maximum rise in volume was recorded in CO 6 (149 ml) followed by VBN 5 (148 ml) and T9 (147 ml) which is an indication of good quality of thick pancake. Thick pancake prepared using 5 black gram varieties were analyzed for the physicochemical and microbial load. The texture profile viz., springiness, cohesiveness, chewiness and gumminess was evaluated for VBN 5, CO 6, T9 and VBN 7 respectively. The protein content was higher in thick pancake prepared from VBN 5 (25.47/100 g) compared to CO 6 (24.66 g/100g). Among the selected varieties, CO 6, T9 and VBN 5 had good batter content, texture, and microstructure and were found to be most suitable for thick pancake preparation.

Introduction

Just like a thick pancake (Dosa) is also a favourite fermented food of India, particularly in the South. The batter preparation for a thick pancake (dosa) is similar to that of idli, except the rice and black gram are finely ground, and this pancake batter is comparatively thinner compared to rice batter. The batter is spread out as a thin, fairly crisp pancake on a greased hot tawa and sparingly sprinkled with oil and cooked crisply on both sides and eaten directly with accompaniments as from idli [1-3]. Instant mixes of traditional products such as idli, dosa and vada based on rice and black gram blend flours are becoming increasingly popular in the Indian market [4-6]. Due to a larger difference in the prices for black gram and other cereals, the manufacturers are tempted to reduce the proportion of black gram in the flour mix while tailoring the texture by use of other processing aids [7].

The pancake is a popular breakfast dish across South Indian homes and a favourite eat-out dish for the rest of India [8]. Quick and easy define it really. Some varieties need no time with the batter; some need a bit of fermentation [6,9]. However, the sum of all products is always the same-tasty dosas. Masala dosa Just plain dosa with a spiced mashed potato filling. Many types of dosa available in the market these are the various types of dosa prepared from black gram such as there are rawa dosa made with semolina and rice flour [10]. No grinding, no fermenting. Just mix the two with water or buttermilk. pesarathu Dosa made of green gram (moong daal). A popular Andhra

Pradesh breakfast and snack, made by mixing chopped green chillies, ginger and onions to the green gram batter. Neer dosa from Karnataka. "Neer" means water in Kannada. Really thin dosa made of water and rice flour [11-13]. No fermenting. Davangere Benne Dosa from Davangere, a north-west Karnataka town. Means butter dosa. Dosa made with white unsalted butter. There are three kinds of these-Benne Khali dosa, Benne open dosa and Benne masala dosa, depending on whether the potato masala is inside or outside the dosa. Adai dosa-Protein-rich dosa made of different types of pulses (urad daal, chana daal, toor daal, yellow and green mong daal, arhar daal) mixed with cumin and fennel seeds and chopped chillies, onions, ginger and coriander or curry leaves [14-16]. Maida Dosa made of maida (plain flour) and rice flour mixed with chopped chillies, onions, ginger and coriander or curry leaves. No fermenting. Atta dosa made of atta (wheat flour) and rice flour, with or without chopped chillies, onions, ginger and coriander or curry leaves. This paper aims to screen blackgram varieties and to record the quality characteristics of thick Pancake (dosa batter) and to evaluate the textural, nutritional, organoleptic and microbiological characteristics of a thick pancake.

Materials and Methods

Samples used

The seeds of black gram variety viz., VBN 3, VBN 4, VBN 5, VBN 6, VBN 7, CO 6, ADT 3, TMV, T9, VBg 010-024, VBg 010-025 and VBg 009-005 were procured from National Pulse Research Institute (Vamban), Agricultural College and Research Institute (Madurai) and Department of Pulses, TNAU (Coimbatore). The seeds of all the varieties were freed from extraneous material and stored in air tight plastic containers under ambient conditions. All other ingredients viz., rice and fenugreek used in the preparation of pan cake batter and pan cake preparation were procured from the local market in Madurai.

Functional and chemical properties of selected black gram varieties

Twelve black gram varieties were screened based on their functional and chemical properties. Functional characteristics such as foaming capacity (FC) and foaming stability (FS) of black gram were measured by the volumetric method as described by Lin et al. [17]. The arabinose and galactose content of selected black gram varieties were analyzed using High-Performance Liquid Chromatography (HPLC) as given by Tanaka [18]. The fatty acid composition was analyzed by solvent extraction method Cohen [19].

Thick pancake batter preparation

For estimating the apparent grain volume, 25 g of split dhal of each variety were measured in a measuring cylinder. The initial batter volume was estimated by measuring the increase in black gram batter in a measuring cylinder, soon after grinding and mixing of rice batter and black gram batter. The final batter volume was estimated by measuring the fermented rice and black gram batter volume after gentle stirring.

Thick pancake preparation

Milled parboiled rice and dehusked black gram dhal were soaked separately in portable water for 6 to 8 hours. The water is drained, and the soaked rice was ground to a fine gelatinous paste, while thus the drained black gram dhal was ground to a fluffy soft texture. The rice and black gram batter were mixed together, and 0.8% salt was added, and the thick pancake (Dosa) batter was incubated at room temperature, and the fermentation was allowed to take place for 12 hrs. The fermented batter was further mixed well with a stainless steel ladle. The batter was spread out as a thin, fairly crisp thick pancake as a greased hot tawa and sparingly sprinkled with oil and cooked crisply on both sides and eaten directly (Figure 1).



Figure 1: hick pancake (Dosa) prepared from screened black gram varieties (TNAU).

Analysis of thick pancake (Dosa) batter

Thick pancake (Dosa) batter was studied for batter volume, batter weight, and increase in batter volume as per method is given by Kanchana et al. [20]. Acidity and pH were analysed as per method is given by Saini et al.; Clark et al, [21,22].

Physico-chemical properties and sensory score thick pancake

The thick pancake samples were analyzed for contents of moisture (AOAC 1995) [23], ash, fat, protein (AOAC 1998) [24], starch (AOAC 2005) [25], calcium, phosphorus and iron were analyzed by dry ashing method (AOAC 2005) [25]. Microbial load of the products were enumerated by Istavankiss [26]. The sensory quality of the product was evaluated using a nine-point hedonic rating scale [27].

Texture and microstructure analysis of thick pancake

Textural parameters of Thick pancake (Dosa) (VBN5, VBN7, CO 6 and T9) viz., hardness, cohesiveness, adhesiveness, springiness, gumminess and chewiness were studied by using texture analyzer (Model TA-Ti, Stable Microsystems, UK). The microstructure of dosa samples was studied under Microscope (Euromex Cmx 3, Netherlands).

Statistical analysis

All results of triplicate samples were statistically analyzed using Fisher's least significant differences (LSD) test to differentiate the treatment means and the level of significance ($P < 0.05$). Statistical analysis was performed by using Statistica Version 5.5 (Statsoft Inc., OK, and the USA) software. In reporting data, the results of individual samples were reported as the mean \pm standard deviation. Factorial Completely Randomized Design (FCRD) as per the method described by Gomez and Gomez [28] was employed for the analysis with a triplicate number of samples.

Results and Discussion

Functional and chemical properties of selected black gram varieties

The foaming capacity of the 12 black gram varieties ranged between 33.33 (VBN 7) to 35.71 (VBN 5) g per cent. Foaming stability was maximum for T9 (35.2 g per cent), followed by VBN 5 (35.12 g per cent) and minimum for VBN 4 (32.46 g per cent) after 120 min of storage. The FC and FS have a significant influence on the textural and leavening properties of idli and thick pancake (dosa) [29]. The mucilaginous texture of black gram is attributed to the arabinogalactan, present exclusively in black gram which is also responsible for smooth, spongy texture of idli and thick pancake (dosa).

The arabinose and galactose content of variety VBN 5 (19.8 and 23.6 mg g⁻¹) were significantly higher followed by T9 (16.9 and 20.1 mg g⁻¹). Black gram polysaccharide may be accounted for exerting higher foaming stability [29,30]. Based on the functional and chemical properties, five black gram varieties viz., VBN 5, T9, ADT 3, CO 6 and VBN 7 were screened and used for the preparation of South Indian breakfast thick pancake dosa. The study results were given for thick pancake (dosa) batter and thick pan cake (dosa).

Analysis of thick pancake batter

The prepared thick pancake batter was studied for physicochemical characteristics. Batter quality analysis such as batter weight (g), batter volume (ml), raise in batter volume (ml), pH and acidity were analyzed from the selected black gram varieties. The black gram varieties viz., VBN 5, T9, ADT 3, CO 6 and VBN 7 were found to have good acceptability for thick pancake development. The batter was prepared from rice and black gram as for thick pancake preparation, and the physicochemical parameters of the batter were evaluated. The physicochemical analyses of thick pancake batter prepared using the selected 5 black gram varieties were assessed for the results are given in table 1. The batter weight reduced gradually during a fermentation period of 18 hours and ranged between 272 and 318 g, and batter volume increased almost two-fold in all the varieties just as for thick pancake batter. The increase in volume ranged between 147 and 149 ml for the batter prepared from 100g of rice and 30 g of black gram. Maximum rise in volume was found in black gram varieties CO 6 (149ml) followed by VBN 5 (148ml), T9 (147ml), VBN 7 (147ml) and ADT 3 (110ml). The rise in volume is an indication of the good quality of batter which is highly suited for thick pancake preparation. The changes in pH and acidity brought about by batter fermentation were evaluated. The pH of the batter ranged 6.18 to 6.20, and after fermentation for 18 hours, the corresponding value ranged from 4.28 to 4.51. The changes in pH are attributed to the concomitant increase in acidity during fermentation which had increased from an initial level of 0.07 to 0.44 g/100g after 18 hours of fermentation.

Physico-chemical properties and sensory score of thick pancake

The data about physical characteristics such as diameter and texture were analyzed thick pancake prepared from selected black gram varieties. The diameter of thick pancake developed from the different black gram varieties ranged from 8.00 to 8.50cm (Table 2). The texture of dosa was assessed regarding the number of pores measured by the ink print test method, where in the applied prints furnish a record

Table 1: Physicochemical characteristics of thick pancake (dosa) batter.

Varieties	Batter weight (g)		Batter volume (ml)		Increase in batter volume (ml)	pH		Acidity (g/100g)	
	Initial	Final	Initial	Final		Initial	Final	Initial	Final
T9	319	318	86	232	147	6.20	4.51	0.0756	0.4430
VBN 5	333	331	90	240	148	6.18	4.52	0.0755	0.4445
CO 6	316	315	88	237	149	6.18	4.35	0.0723	0.4420
ADT 3	320	314	95	205	110	6.18	4.28	0.0712	0.4406
VBN 7	274	272	85	232	147	6.20	4.43	0.0716	0.4410
SED	0.1208		0.1483		0.1245	0.2141		0.3342	
CD(P<0.01)	0.2452**		0.3361**		0.4631**	0.3772**		0.5682*	

Table 2: Physical characteristics of thick pancake (Dosa).

Varieties	Diameter (cm)	Number of pores (Per square inch)
VBN 5	8.50	14
T9	8.15	13
ADT 3	8.10	11
CO 6	8.20	12
VBN 7	8.00	10
SED	0.0212	0.0297
CD(P<0.01)	0.4522**	0.4628*

of the number of pores per square inch in the graph sheets. The texture of the dosa was evaluated by observing the porosity, which indicates the softness of the developed dosa. Among the selected varieties VBN 5, T9, CO 6 and ADT 3 showed maximum pores of 14, 13, 12 and 11 respectively. The higher number of pores in a thick pancake is an indication of the soft texture of idli. Hence the varieties mentioned above were selected for development of thick pancake.

Chemical characteristics of thick pancake

The prepared thick pancake was studied for chemical characteristics such as moisture, protein, ash, fat, starch and organoleptic evaluation from the selected black gram varieties. The chemical composition was given in table 3. Higher moisture content was found in VBN 5 (35.11 g/100g) and CO 6 (33.20 g/100g). The moisture content was highest in the thick pancake sample prepared from VBN 5 indicating moisture and soft texture which is a desired sensory attribute for optimum thick pancake quality. The maximum value for ash content was noted in ADT 3 (9.20 g/100g) followed by VBN 5 (9.10 g/100g), CO 6 (8.20 g/100g), T9 (8.30 g/100g) and VBN 7 (8.00 g/100g). The fat content of the thick pancake sample ranged from 2.10 to 2.50 g/100g with minimum, and maximum values noticed in the thick pancake prepared from varieties VBN 5 and VBN 7 respectively. Thick pancake prepared from variety T9 and ADT 3 had a fat content of 2.12 g to 2.50g /100g. Higher protein content was observed in ADT 3 and CO 6 variety thick pancake with the values of 24.47 and 25.66 g/100g. Significant variation was observed for protein content among the thick pancake samples. The thick pancake prepared from varieties VBN 7, VBN 5, CO 6, ADT 3 and T9 had starch content of 26.00, 29.39, 32.83, 32.00 and 28.00 g/100g respectively. A significant difference was observed for starch content among the thick pancake samples prepared from the different varieties.

The data about the calcium and iron content in variety VBN 7 was 24.00 and 5.10 mg/100g respectively. The calcium content for the other thick pancake samples prepared from varieties CO 6, ADT 3, T9, VBN 5 and VBN 7 was 28.15, 22.46, 25.00, 23.51 and 24.00 mg/100g respectively and the corresponding values for iron content were 5.30, 5.25, 5.40, 5.5 and 5.25 mg/100g respectively. Statistical analysis revealed the highly significant difference between all the dosa samples. Nazini and Shalini [31] reported that on a comparison of the calcium, iron and protein content was found to be maximum in pearl millet idli (41.44, 4.7mg/100g and 9.16 g/100g) followed by multi grain idli (30.48, 2.43mg/100g and 9.10 g/100g) and control idli (26.76, 1.16 mg/100g and 7.28 g/100g) [32] assessed the chemical characteristics of sorghum and moth bean incorporated idli and dosa at 50 per cent level. The moisture, protein, ash and fat content were observed as 32.70, 25.6, 8.20 and 1.65 g/100g.

Organoleptic evaluation of thick pancake

Organoleptic quality of thick pancake was evaluated by 30 semi-trained judges using 9 points hedonic scale rating, and the sensory scores are given in table 4. The quality attributes were assessed for colour, flavour, texture, taste and overall acceptability. Concerning colour, flavour and texture, the score value was higher for VBN 5, CO 6 and T9. The score for taste and overall acceptability ranged between 9.0, 9.0 and 8.8.

Table 3: Chemical characteristics of thick pancake (dosa).

Parameters	VBN 5	T9	ADT 3	CO 6	VBN 7	SED	CD (0.01)
Moisture (g /100g)	35.11	32.50	32.00	33.20	30.00	0.3241	0.4269**
Ash (g /100g)	9.10	8.30	9.2	8.20	8.0	0.3221	0.4337NS
Fat (g /100g)	2.10	2.12	2.50	2.14	2.60	0.0225	0.2084*
Protein (g /100g)	24.22	22.49	24.47	25.66	22.00	0.6826	0.7425*
Starch (g /100g)	29.39	28.00	32.00	32.83	26.00	0.7768	0.7823**
Calcium (mg/100g)	23.51	25.00	22.46	28.15	24.00	0.6752	0.6723**
Iron (mg/100g)	5.5	5.4	5.25	5.3	5.10	0.4060	0.5960**

Table 4: Mean score value of organoleptic characteristics of thick pancake (dosa).

Parameters	VBN 5	T9	ADT 3	CO 6	VBN 7
Appearance and Colour	9.0	8.9	9.0	9.0	8.6
Flavour	8.8	8.8	8.5	8.9	8.3
Texture	8.9	8.9	8.5	8.8	8.4
Taste	8.9	8.8	8.8	9.0	8.4
Over all acceptability	8.8	8.9	8.7	9.0	8.5

The thick pancake (Dosa) samples prepared from black gram varieties VBN 5, CO 6 and T9, were found to have good organoleptic characteristics. Poongodi Vijaya Kumar [33] reported that the softness of dosa from composite flour was marginally less in comparison with the softness of dosa from rice flour. The softness of dosa from 30% MBCF was just about right and others in most of the liking score on softness and also good sensory profile.

Texture Profile Analysis (TPA) and microstructure of thick pancake (Dosa) from best variety

Based on physicochemical properties and sensory evaluation, VBN 5, CO 6 and T9 were found to have maximum acceptability. Hence, texture profile and microstructure of prepared from these two varieties along with a control variety (VBN 7) were analyzed. The texture values of thick pancake (Dosa) are given in table 5. The springiness values of the thick pancake (Dosa) samples prepared from varieties, T9, VBN 5, CO 6 and VBN 7 was 1.044mm, 1.357mm, 1.258mm and 1.024mm respectively. The springiness of thick pancake (Dosa) prepared from VBN 5, CO 6 and T9 varieties were higher when compared to VBN 7 thick pancake (Dosa). Higher springiness value was found in the thick pancake (Dosa) samples prepared from VBN 5 (1.357mm) which was found to be statistically significant ($p < 0.05$) compared to the springiness values of the thick pancake (Dosa) prepared from other black gram varieties. Cohesiveness was maximum for VBN 5 (0.440mm) than VBN 7, CO 6 and T9 which was 0.400, 0.430 and 0.420mm respectively. Chewiness was maximum in T9 (2.994 mm) compared to 2.351, 2.370 and 1.753mm in variety VBN 5, CO 6 and VBN 7 respectively. The highest value for gumminess was observed in T9 (2.892mm) followed by VBN 5 (2.105mm), CO 6 (2.101mm) and VBN 7 (1.581mm). A significant difference ($p < 0.05$) was observed for cohesiveness, gumminess and chewiness of the thick pancake (Dosa) prepared from the different black gram varieties for VBN 5 incorporated thick pancake (Dosa). Springiness i.e., the ability to retain shape and attain the original values after withdrawal of pressure force was maximum for VBN 5 (1.357mm) which also had the highest cohesiveness (0.440mm). So also the chewiness and gumminess were moderate for a thick pancake (Dosa) prepared from VBN 5 (2.105mm) compared to 1.581 and 2.892 mm obtained for VBN 7 and T9. This indicated that VBN 5 and CO 6 was most suitable thick pancake (Dosa) making compared to VBN 7 and T9. Tharnathan and Mahadevamma [34] reported that the fluffiness and sponginess of idli were increased with increase in the proportion of black gram dhal and fermentation time. The maximum score for fluffiness was 11.4 for the idli made with cereal: pulse combination of 3:2 at 12 hours fermentation time, so this same idli batter was used for dosa preparation, so this results also support my studies of a different variety of thick pancake (Dosa) preparation. Poongodi Vijayakumar [33] and Sanz-Serrano et al. [35] stated that the dosa from 30% Millet based composite flour was less cohesive than dosa from other composite flour and rice flour.

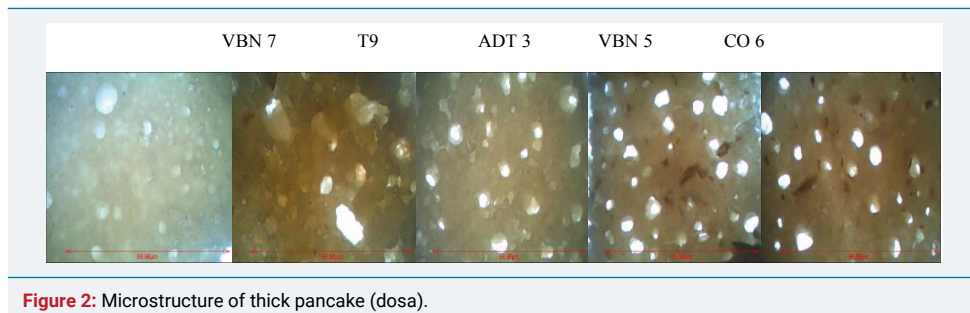
Microstructure

The microstructure of the dosa prepared from varieties VBN 5, T9, CO 6 and ADT 3 was analysed by cutting the thick pancake (Dosa) conforming to 1x1 cm regarding width and breadth. The cut halves were then subjected to the cross-sectional view under a microscope, and the results are shown in figure 2. Microstructure profile reveals the linear profile of leavening of the batter and incorporation of air and porosity of the

Table 5: Texture profile analysis of thick pancake (dosa) prepared from selected black gram varieties.

Varieties	Springiness(mm)	Cohesiveness (mm)	Chewiness (mm)	Gumminess (mm)
VBN 7	1.024 ^a	0.420 ^a	1.753 ^a	1.581 ^a
VBN 5	1.357 ^a	0.440 ^b	2.351 ^b	2.105 ^b
T9	1.044 ^b	0.400 ^a	2.994 ^c	2.892 ^c
CO 6	1.258 ^a	0.430 ^b	2.370 ^b	2.101 ^b

Values followed by the same letter within a column do not differ significantly ($p < 0.05$).

**Figure 2:** Microstructure of thick pancake (dosa).

product. Higher the numbers of pores were found to correlate to better batter quality, foaming capacity and the content of the mucilaginous substance arabinogalactan in the black gram variety. The texture and softness level was higher in thick pancake (Dosa) developed from VBN 5 and T9 varieties compared to VBN 7. Kanchana et al. [20] and Lu et al. [36] studied the microstructure rupture of idli and dosa from selected rice and pulse varieties. The texture was found to be very soft and more pores were present in idli and dosa prepared from rice variety (Ambai16, Ambai36, ASD19, CR1009) and black gram variety CO 6 and T9. Similar observations seen in the present study with variety CO 6 and T9 which exhibited good thick pancake (Dosa) making quality on par with variety VBN 5.

Conclusion

In this study, VBN 5, CO 6 and T9 were found to be better for thick pancake (Dosa) preparation. The best varieties contain a higher amount of arabinogalactan and mucilaginous content. Due to higher batter quality and good foaming stability, the textural properties of thick pancake (Dosa) was soft and good in nature in VBN 5, CO 6 and T9 varieties. Thick pancake (Dosa) prepared were found to be as organoleptically and nutritionally superior regarding protein, starch, fat, and mineral contents.

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